

CLAIMS

1. A removable filter for capturing thrombi in a blood vessel, the filter comprising:

a plurality of primary struts having first ends connected to each other to define a central axis of the filter, each primary strut having a curved member extending from the central axis and terminating at an anchoring hook to engage the blood vessel at a first axial plane; and

a plurality of secondary struts connected to the curved members of the primary struts and extending therefrom to free ends at a second axial plane to centralize the filter in the blood vessel.

2. The removable filter of claim 1 wherein a set of at least two secondary struts are connected to one primary strut, the set of secondary struts extending radially from each side of the primary strut.

3. The removable filter of claim 1 wherein one secondary strut is connected to one primary strut, the secondary strut extending from the primary strut and being in radial alignment with the primary strut.

4. The removable filter of claim 1 wherein the curved member includes a first curved portion and a second curved portion, the first curved portion extending from the first end, the second curved portion extending from the first curved portion and terminating at the anchoring hook.

5. The removable filter of claim 4 wherein the first curved portion is configured to extend radially from the central axis of the filter and the second curved portion is configured to extend radially toward the central axis of the filter.

6. The removable filter of claim 4 wherein the first and second curved portions are configured to have a non-parallel relationship with the central axis of the filter.

7. The removable filter of claim 4 wherein each secondary strut is connected to one of the first curved portions and extends therefrom to the free end.

8. The removable filter of claim 1 wherein the anchoring hook includes a barb for engaging the wall of the blood vessel, the barb being configured to project toward the first end.

9. The removable filter of claim 1 further comprising:
a hub configured to axially house the first ends of the plurality of primary struts; and
a retrieval hook extending from the hub opposite the plurality of primary struts for removal of the filter from the blood vessel.

10. The removable filter of claim 1 wherein the second axial plane is defined between the first ends and the anchoring hooks of the plurality of primary struts.

11. The removable filter of claim 1 wherein each primary strut has a diameter of about 0.015 inch.

12. The removable filter of claim 1 wherein each primary strut is formed of a superelastic material.

13. The removable filter of claim 1 wherein each secondary strut has a diameter of 0.012 inch.

14. The removable filter of claim 1 wherein each secondary strut is formed of a superelastic material.

15. The removable filter of claim 1 wherein the primary struts and the secondary struts expand to a diameter of about 35 millimeters.

16. The removable filter of claim 15 wherein the length of each primary strut is about 5 centimeters.

17. The removable filter of claim 1 wherein the primary struts and the secondary struts include a minimal diameter defining a collapsed configuration of the filter and a maximum diameter defining an expanded configuration of the filter.

18. The removable filter of claim 17 wherein the primary struts are configured to pivot at the first ends thereof to move between the collapsed and expanded configurations.

19. The removable filter of claim 1 wherein each secondary strut is connected to a primary strut by at least one of the following means: laser welding, brazing, or crimping.

20. A removable filter for capturing thrombi in a blood vessel, the filter comprising:

a plurality of primary struts having first ends axially connected to each other to define a central axis of the filter, each primary strut having a curved member extending from the central axis and terminating at an anchoring hook to engage the blood vessel at a first axial plane; and

a plurality of secondary struts connected to one of the curved members, each secondary strut extending therefrom to a free end at a second axial plane to centralize the filter in the blood vessel.

21. The removable filter of claim 20 wherein a set of at least two secondary struts are connected to one primary strut, the set of secondary struts extending radially from each side of the primary strut.

22. The removable filter of claim 20 wherein the curved member includes a first curved portion and a second curved portion, the first curved portion extending

from the first end, the second curved portion extending from the first curved portion and terminating at the anchoring hook.

23. The removable filter of claim 22 wherein the first curved portion is configured to extend radially from the central axis of the filter and the second curved portion is configured to extend radially toward the central axis of the filter.

24. The removable filter of claim 22 wherein the first and second curved portions are configured to have a non-parallel relationship with the central axis of the filter.

25. The removable filter of claim 22 wherein each secondary strut is connected to one of the first curved portions and extends therefrom to the free end.

26. The removable filter of claim 20 wherein the anchoring hook includes a barb for engaging the wall of the blood vessel, the barb being configured to project toward the first end.

27. The removable filter of claim 20 further comprising:
a hub configured to axially house the first ends of the plurality of primary struts; and
a retrieval hook extending from the hub opposite the plurality of primary struts for removal of the filter from the blood vessel.

28. The removable filter of claim 20 wherein the second axial plane is defined between the first ends and the anchoring hooks of the plurality of primary struts.

29. The removable filter of claim 20 wherein each primary strut has a diameter of about 0.015 inch.

30. The removable filter of claim 20 wherein each primary strut is formed of a superelastic material.

31. The removable filter of claim 20 wherein each secondary strut has a diameter of 0.012 inch.

32. The removable filter of claim 20 wherein each secondary strut is formed of a superelastic material.

33. The removable filter of claim 20 wherein the primary struts and the secondary struts expand to a diameter of about 35 millimeters.

34. The removable filter of claim 33 wherein the length of each primary strut is about 5 centimeters.

35. The removable filter of claim 20 wherein the primary struts and the secondary struts include a minimal diameter defining a collapsed configuration of the filter and a maximum diameter defining an expanded configuration of the filter.

36. The removable filter of claim 35 wherein the primary struts are configured to pivot at the first ends thereof to move between the collapsed and expanded configurations.

37. The removable filter of claim 20 wherein each secondary strut is connected to a primary strut by at least one of the following means: laser welding, brazing, or crimping.

38. A removable filter for capturing thrombi in a blood vessel, the filter comprising:

a plurality of primary struts having first ends axially connected to each other to define a central axis of the filter, each primary strut having a curved member extending from the central axis and terminating at an anchoring hook to engage the blood vessel at a first axial plane; and

a plurality of secondary struts, one secondary strut connected to one of the curved members and extending therefrom to a free end at a second axial plane to centralize the filter in the blood vessel.

39. The removable filter of claim 38 wherein one secondary strut is connected to one primary strut, the secondary strut extending from the primary strut and being in radial alignment with the primary strut.

40. The removable filter of claim 38 wherein the curved member includes a first curved portion and a second curved portion, the first curved portion extending from the first end, the second curved portion extending from the first curved portion and terminating at the anchoring hook.

41. The removable filter of claim 40 wherein the first curved portion is configured to extend radially from the central axis of the filter and the second curved portion is configured to extend radially toward the central axis of the filter.

42. The removable filter of claim 40 wherein the first and second curved portions are configured to have a non-parallel relationship with the central axis of the filter.

43. The removable filter of claim 40 wherein each secondary strut is connected to one of the first curved portions and extends therefrom to the free end.

44. The removable filter of claim 38 wherein the anchoring hook includes a barb for engaging the wall of the blood vessel, the barb being configured to project toward the first end.

45. The removable filter of claim 38 further comprising:

a hub configured to axially house the first ends of the plurality of primary struts; and

a retrieval hook extending from the hub opposite the plurality of primary struts for removal of the filter from the blood vessel.

46. The removable filter of claim 38 wherein the second axial plane is defined between the first ends and the anchoring hooks of the plurality of primary struts.

47. The removable filter of claim 38 wherein each primary strut has a diameter of about 0.015 inch.

48. The removable filter of claim 38 wherein each primary strut is formed of a superelastic material.

49. The removable filter of claim 38 wherein each secondary strut has a diameter of 0.012 inch.

50. The removable filter of claim 38 wherein each secondary strut is formed of a superelastic material.

51. The removable filter of claim 38 wherein the primary struts and the secondary struts expand to a diameter of about 35 millimeters.

52. The removable filter of claim 51 wherein the length of each primary strut is about 5 centimeters.

53. The removable filter of claim 38 wherein the primary struts and the secondary struts include a minimal diameter defining a collapsed configuration of the filter and a maximum diameter defining an expanded configuration of the filter.

54. The removable filter of claim 53 wherein the primary struts are configured to pivot at the first ends thereof to move between the collapsed and expanded configurations.

55. The removable filter of claim 38 wherein each secondary strut is connected to a primary strut by at least one of the following means: laser welding, brazing, or crimping.